

LARGE-TIMESTEP TECHNIQUES FOR PARTICLE-IN-CELL SIMULATION
OF SYSTEMS WITH APPLIED FIELDS THAT VARY RAPIDLY IN SPACE*

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ABSTRACT

Under conditions which arise commonly in space-charge-dominated beam applications, the applied focusing, bending, and accelerating fields vary rapidly with axial position, while the self-fields (which are, on average, comparable in strength to the applied fields) vary smoothly. In such cases it is desirable to employ timesteps which advance the particles over distances greater than the characteristic scales over which the applied fields vary. A simple such technique, used in the WARP code[1,2], is the "residence correction," whereby the impulse imparted by an (idealized) sharp-edged element is corrected to reflect the fraction of the velocity-advance step during which the particle resides within the element. It is desirable to extend this concept to cases where the effects of extended fringe fields and other smooth but rapid variations must be accurately captured. Several related concepts are potentially applicable: use of a higher-order time-advance algorithm, sub-cycling of the particle advance relative to the field solution, and force-averaging by integration along approximate orbits. We report on our investigations into the utility of such techniques for systems typical of those encountered in accelerator studies for heavy-ion beam-driven inertial fusion.

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[1] A. Friedman, D. P. Grote, and I. Haber, "Three-Dimensional Particle Simulation of Heavy-Ion Fusion Beams," Phys. Fluids B 4, 2203 (1992).

[2] D. P. Grote, A. Friedman, I. Haber, and S. S. Yu, "Three-Dimensional Simulation of High-Current Beams in Induction Accelerators with WARP3d," Proc. Int. Sympos. on Heavy Ion Inertial Fusion, Princeton, Sept. 6-9, 1995; to be publ. in Journal of Fusion Engineering Design, 1996.